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GB 2217151 A EP 0218482 A2 EP 0196834 A2
EP 0148458 A2 US 4748685 A US 4639550 A

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UK CL (Edition O) H4L LDJ LDLX LECTS LECTX LECX
INT CL^6 H04B 1/38 , H04M 1/72 , H04Q 7/32
ONLINE DATABASE:WPI

(54) **Transmitting data between mobile unit and base unit via battery charging contacts**

(57) A wireless communication system has a base unit 122 with a battery charger 212, and a mobile unit 126 (e.g cordless or cellular phone) having a battery 204 which may be detachable. When the mobile unit is placed in the base unit, data is transmitted between base unit and mobile unit via battery charging contacts 214, 216 and 220,222. For data transmission to the mobile unit, the charging current is pulsed with varying time intervals. A voltage measuring circuit such as an A/D converter connected across contacts 228, 230 detects momentary variations in the battery voltage caused by the charging pulses in order to interpret the data. For data transmission to the base unit, the load on the battery is varied by for example enabling or disabling components in the mobile unit so that the base station decodes variations in the battery voltage in the same manner. Channel or frequency information or repertory dialing information can be sent to the mobile unit from a wide area network via the base unit.

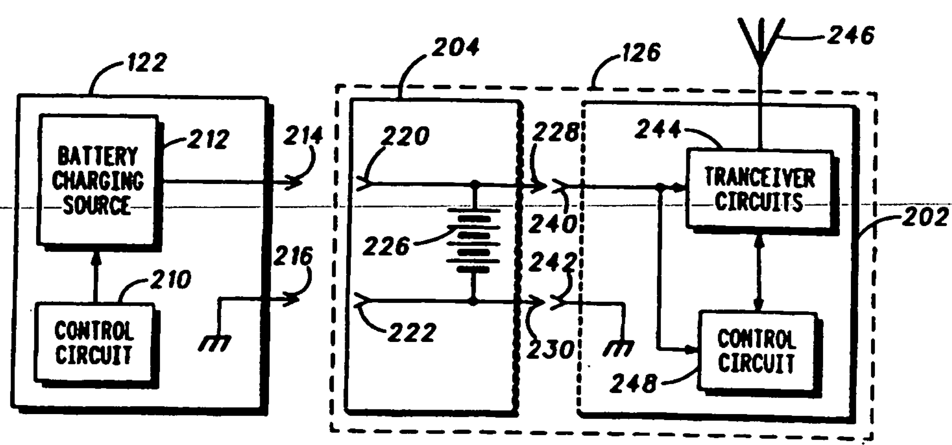


FIG. 2

GB 2 310 344 A

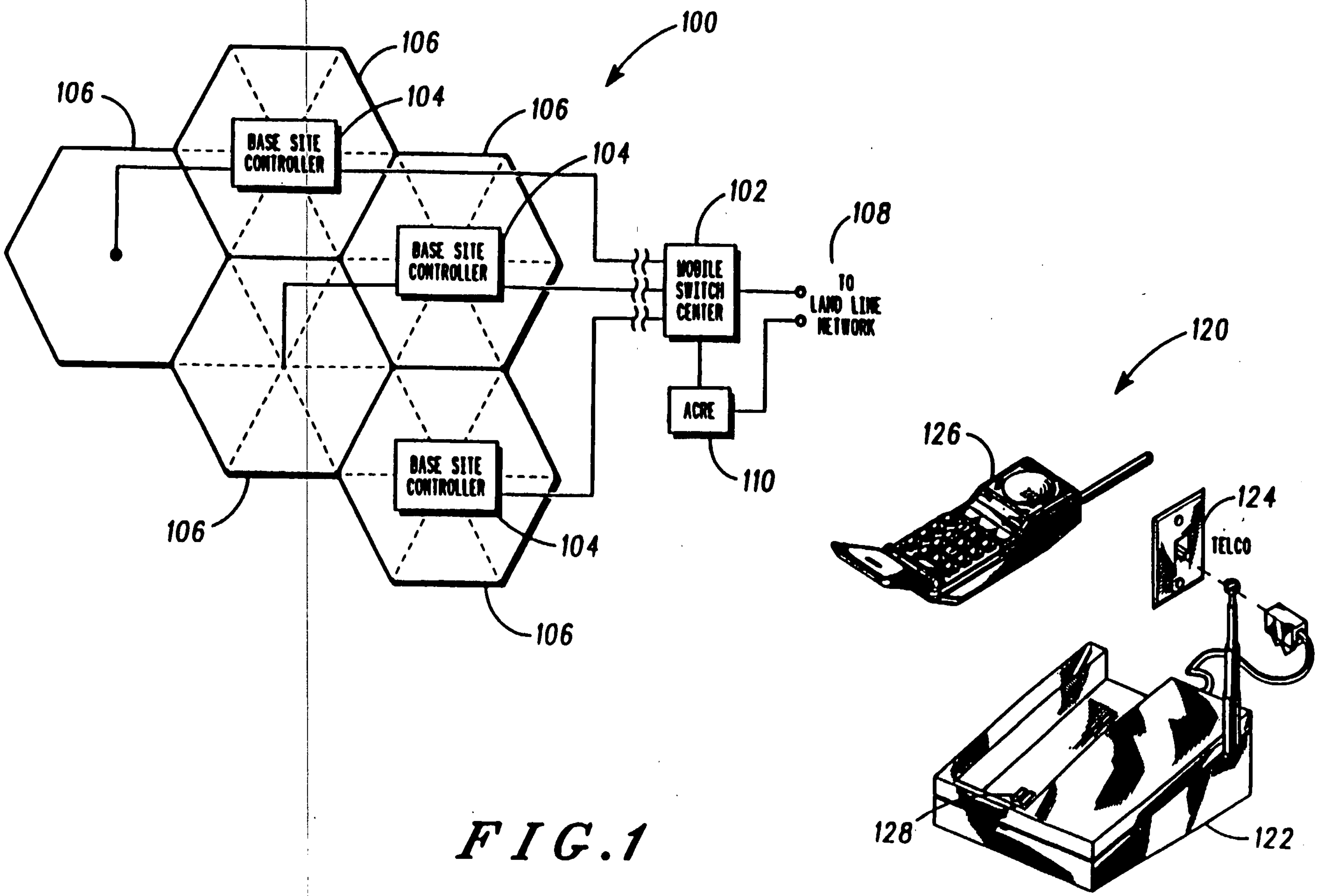

100
106
104
BASE SITE CONTROLLER
102
MOBILE SWITCH CENTER
108
TO LAND LINE NETWORK
ACRE
110
120
126
124
TELCO
128
122

FIG.1

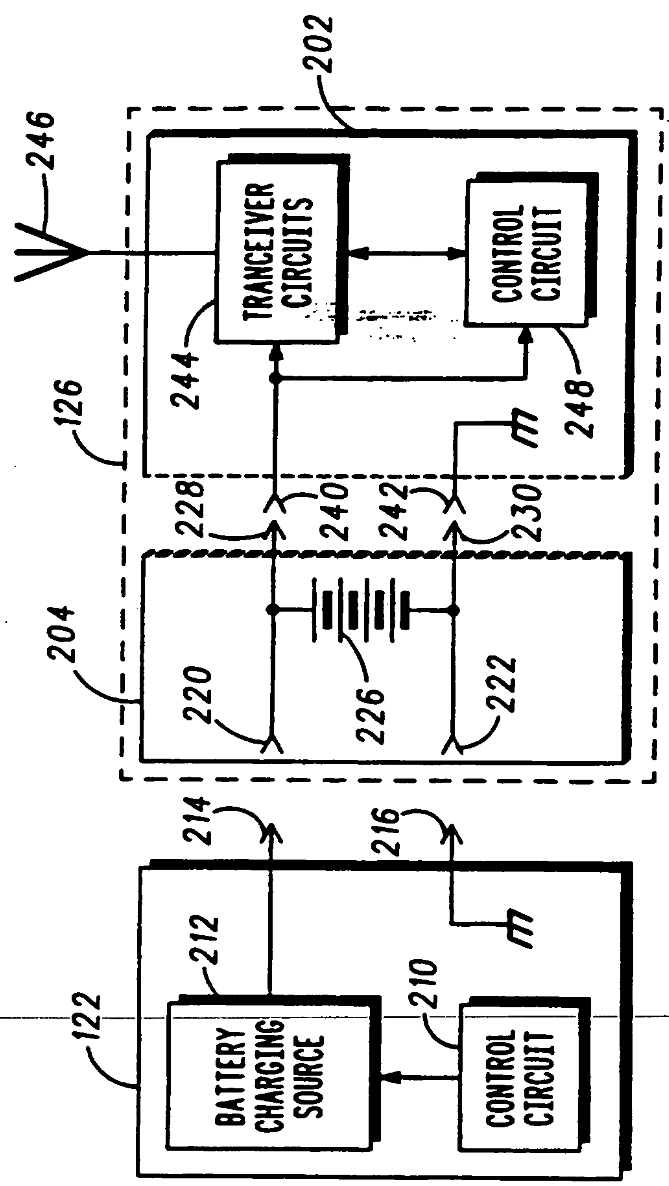

246
202
TRANCEIVER CIRCUITS
CONTROL CIRCUIT
244
248
126
228
240
242
230
204
220
226
222
214
216
212
210
122
BATTERY CHARGING SOURCE
CONTROL CIRCUIT

FIG. 2

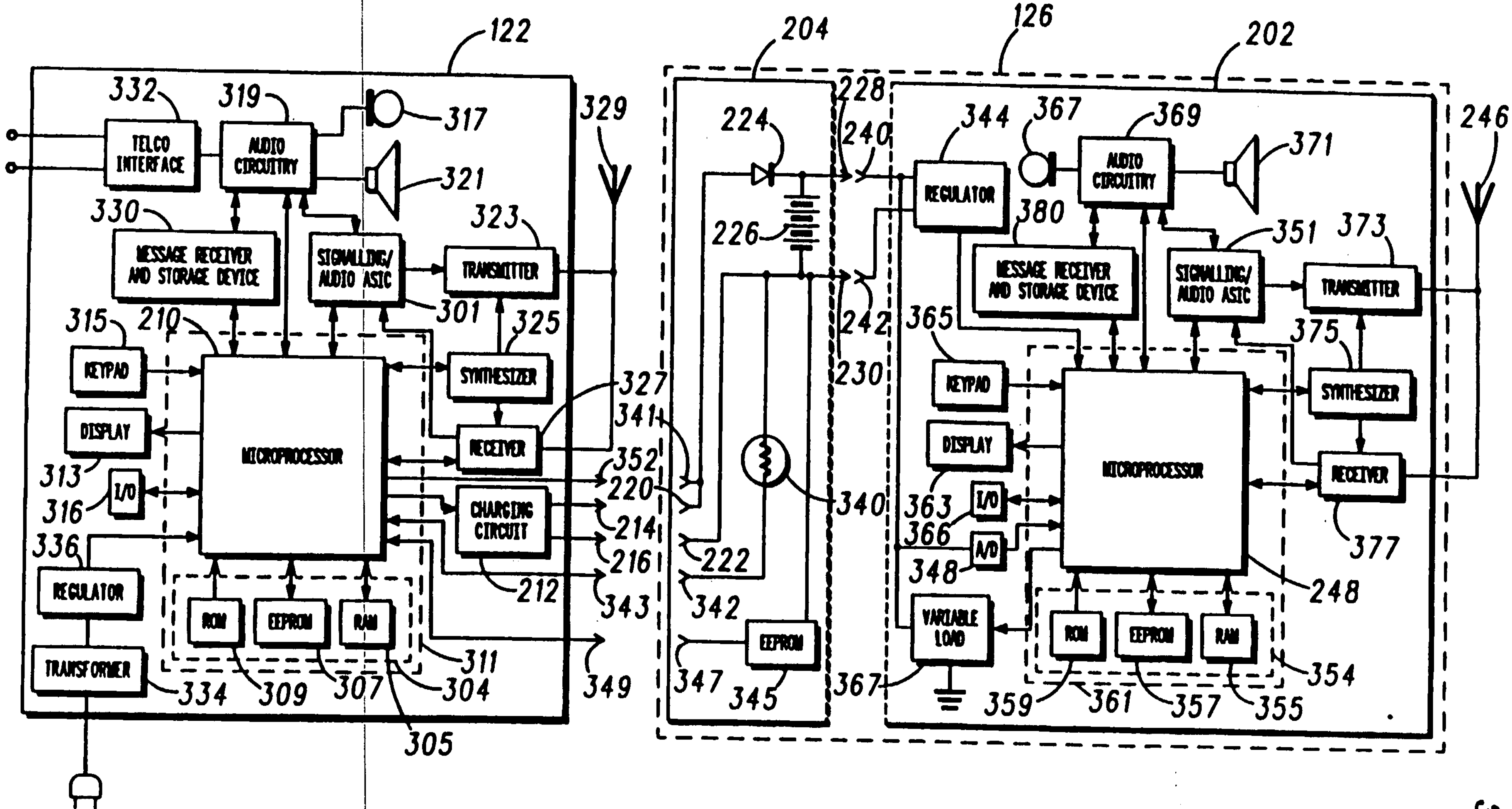
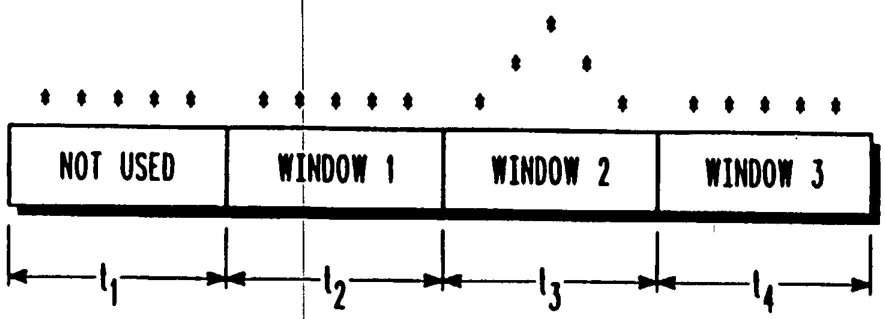
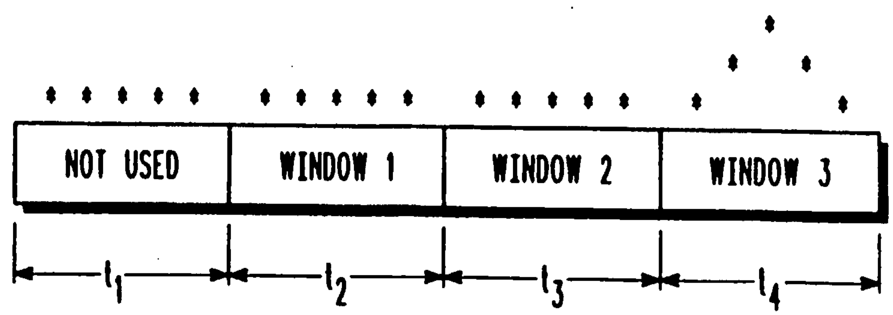

TELCO INTERFACE
AUDIO CIRCUITRY
MESSAGE RECEIVER AND STORAGE DEVICE
SIGNALLING/ AUDIO ASIC
TRANSMITTER
SYNTHESIZER
RECEIVER
CHARGING CIRCUIT
MICROPROCESSOR
KEYPAD
DISPLAY
I/O
REGULATOR
TRANSFORMER
ROM
EEPROM
RAM
VARIABLE LOAD
A/D

FIG.3



REPRESENTATION OF 'ZERO' PULSE

FIG.4



REPRESENTATION OF 'ONE' PULSE

FIG.5

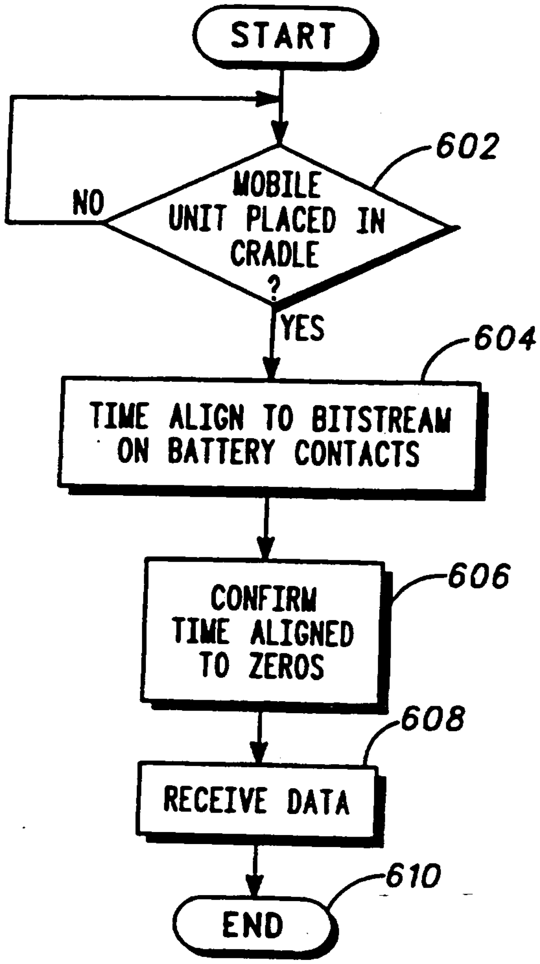

START
602
NO
MOBILE UNIT PLACED IN CRADLE ?
YES
604
TIME ALIGN TO BITSTREAM ON BATTERY CONTACTS
606
CONFIRM TIME ALIGNED TO ZEROS
608
RECEIVE DATA
610
END

FIG.6

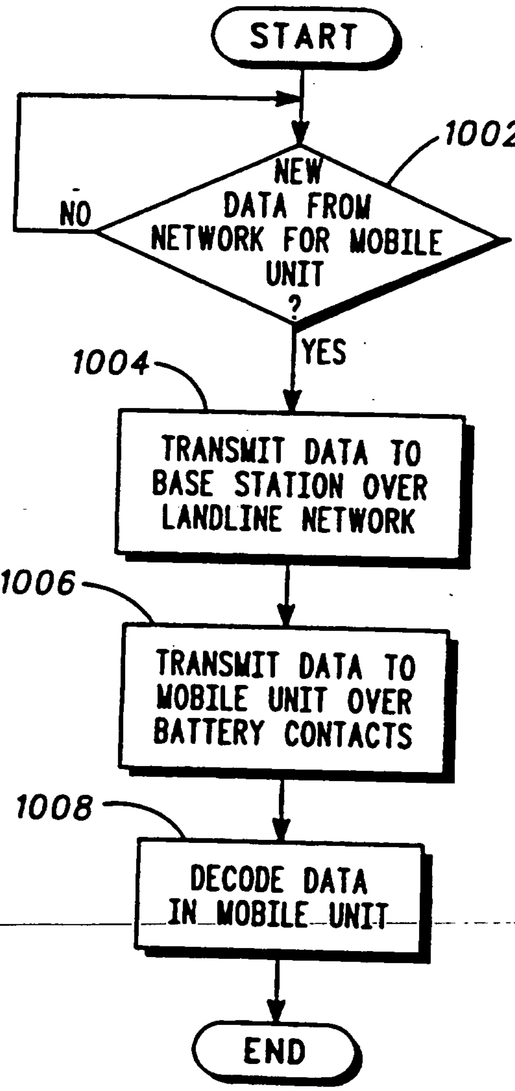

START
1002
NO
NEW DATA FROM NETWORK FOR MOBILE UNIT ?
YES
1004
TRANSMIT DATA TO BASE STATION OVER LANDLINE NETWORK
1006
TRANSMIT DATA TO MOBILE UNIT OVER BATTERY CONTACTS
1008
DECODE DATA IN MOBILE UNIT
END

FIG.10

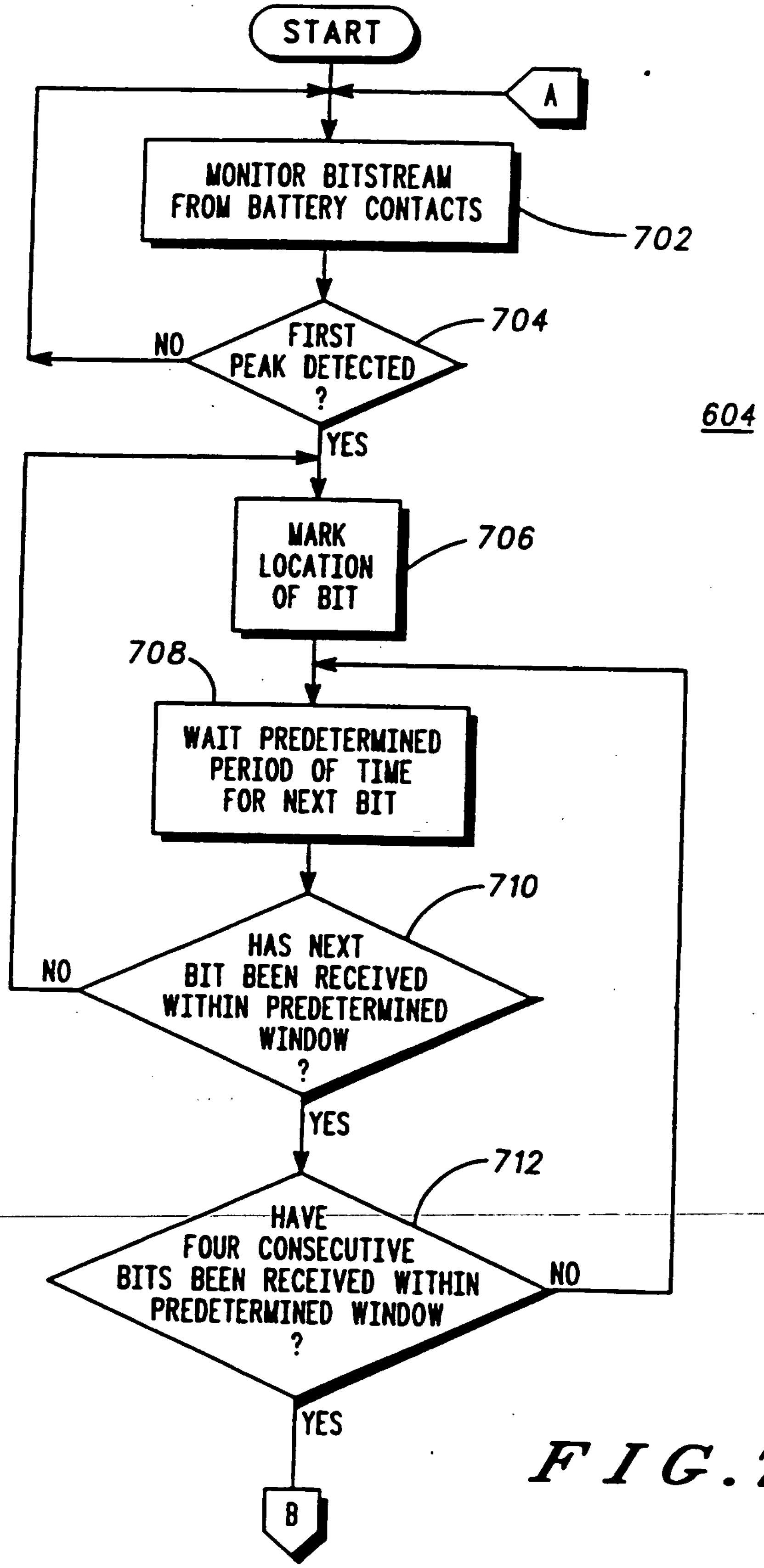

START
A
MONITOR BITSTREAM FROM BATTERY CONTACTS
702
FIRST PEAK DETECTED ?
704
NO
YES
604
MARK LOCATION OF BIT
706
708
WAIT PREDETERMINED PERIOD OF TIME FOR NEXT BIT
HAS NEXT BIT BEEN RECEIVED WITHIN PREDETERMINED WINDOW ?
710
NO
YES
HAVE FOUR CONSECUTIVE BITS BEEN RECEIVED WITHIN PREDETERMINED WINDOW ?
712
NO
YES
B

FIG. 7

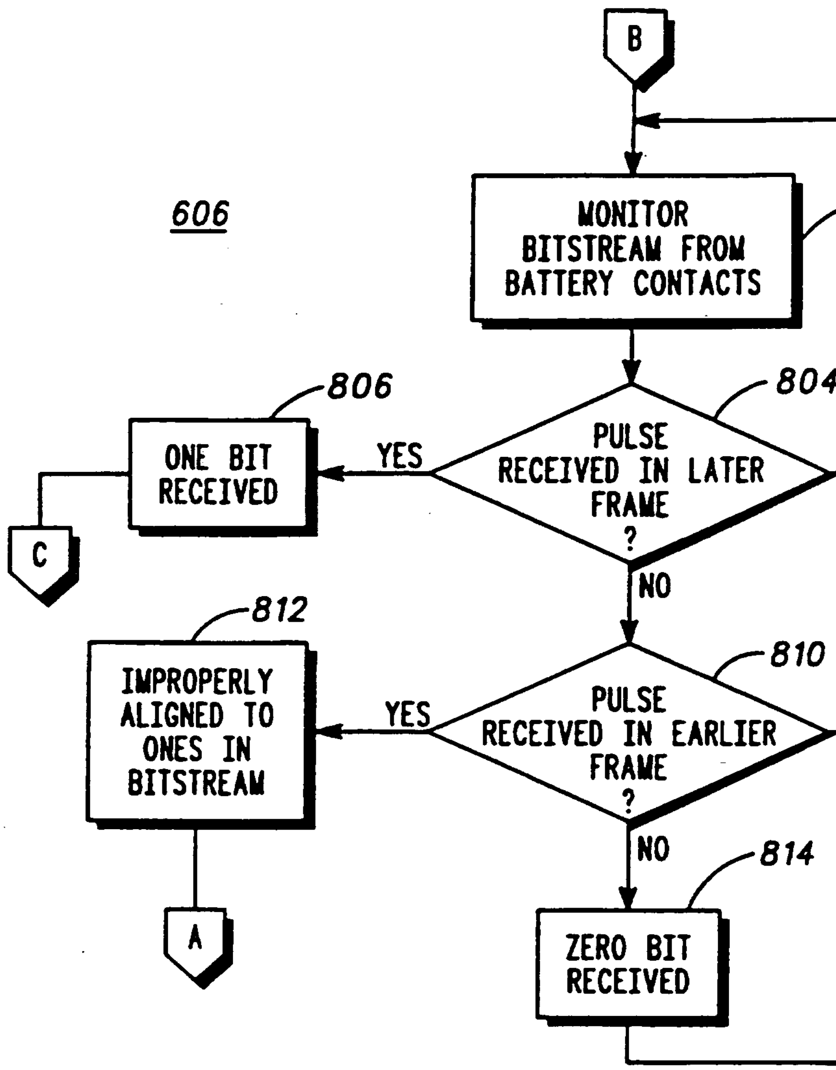

606
B
MONITOR BITSTREAM FROM BATTERY CONTACTS
802
PULSE RECEIVED IN LATER FRAME ?
804
YES
ONE BIT RECEIVED
806
C
NO
PULSE RECEIVED IN EARLIER FRAME ?
810
YES
IMPROPERLY ALIGNED TO ONES IN BITSTREAM
812
A
NO
ZERO BIT RECEIVED
814

FIG.8

608

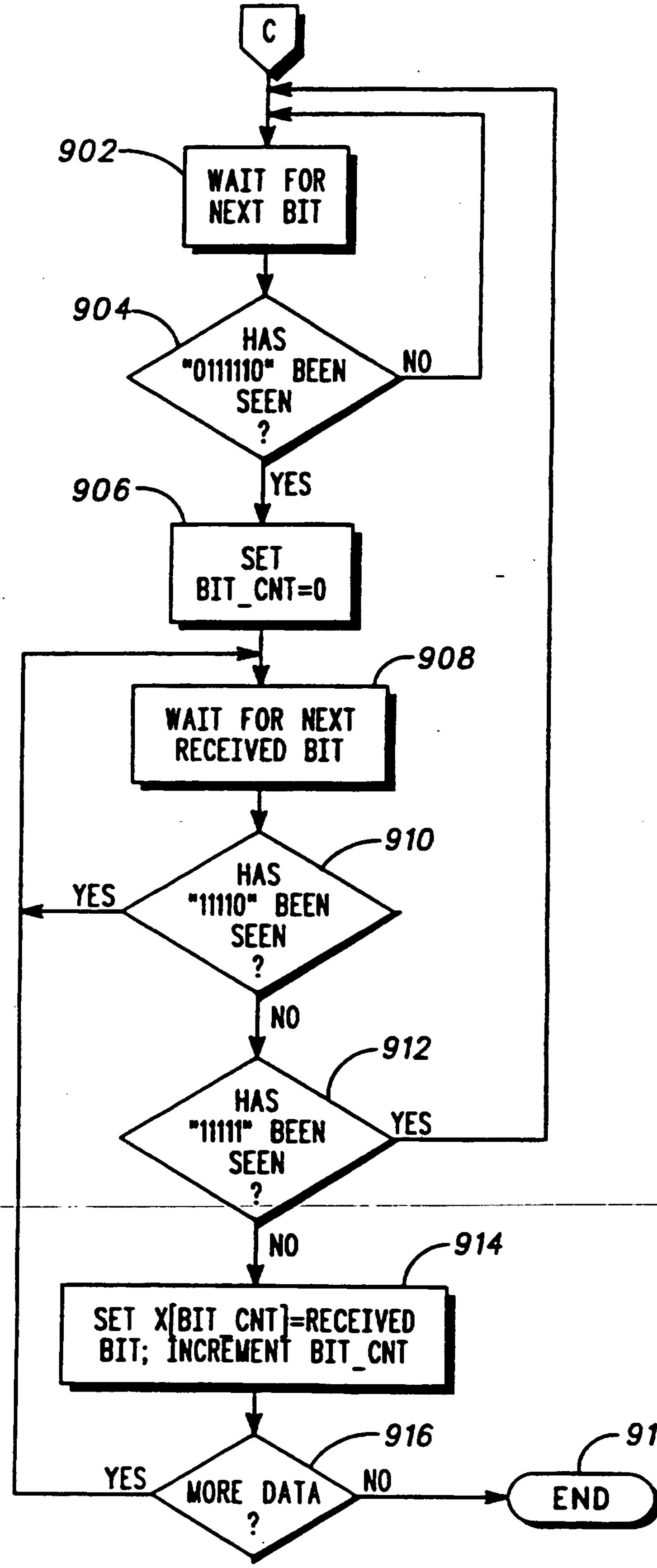

C
902
WAIT FOR NEXT BIT
904
HAS "0111110" BEEN SEEN ?
NO
YES
906
SET BIT_CNT=0
908
WAIT FOR NEXT RECEIVED BIT
910
HAS "11110" BEEN SEEN ?
YES
NO
912
HAS "11111" BEEN SEEN ?
YES
NO
914
SET X[BIT_CNT]=RECEIVED BIT; INCREMENT BIT_CNT
916
MORE DATA ?
YES
NO
918
END

FIG. 9

2310344

METHOD AND APPARATUS FOR TRANSMITTING DATA

Field of the Invention

The present invention generally relates to electronic devices, and more particularly to a method and apparatus for transmitting data over charging contacts between a charging device and a portable device.

Background of the Invention

As communication systems continue to advance, the systems must be flexible to allow communication between various elements of the system. Wireless communication networks currently being developed allow for communication between a single mobile unit, such as a radiotelephone, and multiple communication systems, including a residential cordless system, a wireless in-building system, as well as wide area communication networks, such as a PCS system, a cellular system or other wireless communication systems. The mobile unit is adapted to communicate with a predetermined system depending upon its location within the relevant systems with which it can communicate. Preferably, the mobile unit will communicate with the system which provides the lowest cost of operation.

Communication systems incorporating base stations adapted to electro-mechanically couple to the mobile unit may require information to be transmitted directly between the base station and the mobile unit by way of electrical contacts. Conventional communication devices have transmitted data between a mobile unit and a base station by detecting modulation of the charging current on the charging contacts. As shown for example in US Patent 4,731,813 to Schroeder, an address code stored in the base station is transferred to the mobile unit by modulating the charging current supplied by charging contacts of the base station. When the mobile unit is positioned in the base station, the batteries of mobile unit are recharged by current supplied by the base unit. At the same time, the address code of the base unit is entered into the mobile unit by encoding circuitry which modulates the battery charging current in accordance with address code. Circuitry within

the mobile unit demodulates the charging current to recover the address code.

However, the device of Schroeder has limited applications. In particular, circuitry within the mobile unit must have access to the charging current contact in order to demodulate the charging current as taught by Schroeder. Many conventional mobile units include detachable batteries having a predetermined number of contacts, including charging and ground contacts adapted to be coupled to corresponding charging and ground contacts of the charger. The detachable battery may have a separate pair of power and ground contacts on an internal surface of the battery which are adapted to be coupled to corresponding power and ground contacts associated with the mobile unit. Therefore, the mobile unit does not have access to the charging contacts of the battery or the charger, and therefore cannot detect a modulation of the charging current.

Finally, a communication system having a mobile unit adapted to communicate with multiple systems may require that information be transferred from the wide area network to the base station and/or the mobile unit. In a communication system which may operate on a residential cordless system or in-building system on frequencies which overlap with or are a subset of frequencies on a wide area network, it may be necessary to periodically change the range of frequencies on which the residential cordless or in-building system is operating. This change of frequency range must be communicated to both the base station and the mobile unit. One solution would be to transfer the channel information to the mobile unit directly on the wide area network. However, such a transfer of information may require alteration to the entire infrastructure of the wide area network. Further, it is possible that the mobile unit or base station may be located outside the operating range of the wide area network. Although the mobile unit could scan all possible channels if the channel numbers had changed to find the channel on which its associated base is transmitting, there may be a large number of channels to scan which may take considerable time.

Accordingly, there is a need for a method and apparatus for transmitting data between a base station and a mobile unit when the circuitry of the mobile unit does not have access to the charging current contact.

There is a further need for a method and apparatus for transferring data from a communication network to mobile unit by way of a base station.

Brief Description of the Drawings

FIG. 1 is system level diagram of a wireless communication system according to the present invention;

FIG. 2 is a block diagram of a system for transmitting data according to the present invention;

FIG. 3 is a block diagram of a mobile unit and base station incorporating the system for transmitting data of FIG. 2;

FIG. 4 is a frame diagram showing the pulse representation of a zero bit;

FIG. 5 is a frame diagram showing the pulse representations of a one bit;

FIG. 6 is a flow diagram showing the transfer of data between a base station and a mobile unit by way of the charging contacts;

FIG. 7 is a flow diagram showing the time alignment of the mobile unit to the base station at step 604 of FIG. 6;

FIG. 8 is a flow chart showing the synchronization of the mobile unit to the base station at step 606 of FIG. 6;

FIG. 9 is a flow chart showing the steps of receiving data at step 608 of FIG. 6; and

FIG. 10 is a flow chart showing the transfer of data from a communication network to the mobile unit according to the present invention.

Detailed Description of the Invention

A unique method and apparatus enables the transfer of communication signals via the battery contacts which a base station, such as a residential base station, uses for charging the battery of a mobile unit, such as a radiotelephone. Pulse Position Modulation (PPM) varies the timing of the charging pulses to create the contents of the data stream detected in the battery of the mobile unit. The method and apparatus finds particular application in the transfers of data by way of a wide area network to a mobile unit associated with a base station. For example, a remote device such as a computer having a modem coupled to a wide area network can then communicate an initial channel and a range or list of channels to a base station. The computer could be coupled to a cellular network or directly to a landline network. The base station could then transmit the channel information via the battery bus so that the mobile unit can find the channel on which the base station is transmitting whenever it is in trickle charge or maintenance charge modes.

Turning first to FIG. 1, a wide area communication network 100, such as a cellular radio telephone system, a PCS system, a paging system or some other wireless network, comprises a mobile switch center 102 connected to a plurality of base site controllers 104 in cells 106. Mobile switch center 102 is also preferably coupled to a landline communication network 108. Authorization and Call Routing Equipment (ACRE) 110 is coupled to the mobile switch center 102, or could be coupled directly to a landline network 108 or any other communication network. ACRE 110 provides call routing information to a telephone switching system. The switching system automatically routes phone calls between cellular, microcellular and cordless systems, or other communication networks. ACRE 110 also authorizes communication with a communication system 120 having a base station 122 and a mobile unit 126, such as residential or in-building systems. Base station 122 is preferably coupled to a TELCO 124.

Base station 122 further includes charging contacts 128 which are adapted to couple corresponding charging contacts on a battery associated with mobile unit 126. The charging contact arrangement will be shown in more detail in reference to FIG. 2. Mobile unit 126 is adapted to

communicate with one or more communication networks, such as the wide area communication network 100 or base station 122 by way of radio frequency (RF) communication signals. Mobile unit 126 is further adapted to communicate with base station 122 by way of charging contacts 128 according to the method and apparatus of the present invention.

Turning now to FIG. 2, a block diagram shows an apparatus for transmitting data according to the present invention. In particular, base station 122 comprises control circuit 210 coupled to a battery charging source 212. Battery charging source 212 could be, for example, a current source or a voltage source. Mobile unit 126 comprises a transceiver portion 202 and a battery 204. A charging contact 214 and a ground contact 216 of base station 122 are adapted to couple to battery 204 of mobile unit 126 to charge the battery. Bround contact 216 provides a reference voltage. Although battery 204 is shown as a detachable battery, it could be integrally associated with transceiver portion 202 according to the present invention. Battery 204 comprises a charging contact 220 and ground contact 222 which are adapted to mate with charging contact 214 and ground contact 216, respectively. Battery 204 further comprises a charge storage device or an energy storage device such as an electrochemical cell or battery 226. A negative terminal of battery 226 is also coupled to ground contact 222. Finally, battery 204 comprises a battery contact 228 and a ground contact 230 which are adapted to couple to a power contact 240 and a ground contact 242, respectively, of transceiver portion 202. Power contact 240 is coupled to transceiver circuit 244 and control circuit 248. Control circuit 248 preferably includes an analog-to-digital conversion circuit for determining the voltage on battery 226 and decoding circuitry for decoding any signal based upon variations in the battery voltage. Because it is desirable to fast charge a battery of the mobile unit, the connection from the base station to the battery should be a very low impedance. Although a high impedance would enable the base station to easily diplex data signals and battery charging current on the same contacts, such a high impedance arrangement would significantly restrict the charging rate of the battery.

Turning now to FIG. 3, a block diagram shows a base station and mobile unit incorporating the system for transmitting data according to the present invention. In the preferred embodiment, base station 122 comprises

a signalling ASIC 301, such as a CMOS ASIC available from Motorola, Inc. and a control circuit 210, such as a 68HC11 microprocessor also available from Motorola, Inc., which combine to generate the necessary communication protocol for transmitting RF communication signals to and receiving RF communication signals from mobile unit 126. Control circuit 210 uses memory 304 comprising RAM 305, EEPROM 307, and ROM 309, preferably consolidated in one package 311, to execute the steps necessary to generate the protocol and to perform other functions for the base station, such as writing to a display 313, accepting information from a keypad 315, accepting input/output information by way of a connector 316 or controlling a frequency synthesizer 325. ASIC 301 processes audio transformed by audio circuitry 319 from a microphone 317 and to a speaker 321.

A transceiver processes the radio frequency signals, preferably from mobile unit 126. In particular, a transmitter 323 transmits through an antenna 329 using carrier frequencies produced by a frequency synthesizer 325. Information received by an antenna 329 enters receiver 327 which demodulates the symbols using the carrier frequencies from frequency synthesizer 325. The base station may optionally include a message receiver and storage device 330 including digital signal processing means. The message receiver and storage device could be, for example, a digital answering machine or a paging receiver. Base station 122 further includes a TELCO interface 332 coupled to audio circuitry. The base station is connected to a standard telephone system network by means of a standard telephone cord. When installed, access to the telephone system is provided whereby the base station can accept signals from and provide signals to other units connected in the telephone network. A transformer 334 coupled to receive an external source of power and a regulator 336 provide a regulated source of power to control circuit 210 and other components of base station 122. Finally, a charging source 212 having a charging contact 214 and a ground contact 216 generates a pulse as shown in FIGs. 4 and 5 by preferably modulating a current to apply a 125 msec pulse of 650 milliamperes (mA) of current. However, any duration of some other appropriate current level could be used to transmit the pulse according to the present invention. The duration and current could also be varied depending on the battery being used.

Mobile unit 126 associated with base station 122 includes battery 204, which is preferably a rechargeable battery comprising diode 224 coupled to a positive terminal of battery 226 at battery contact 228 which is adapted to be coupled to power contact 240 of transceiver portion 202. Diode 224 is optional and may be coupled to charging contact 220 to prevent discharging of the battery if charging contact 220 is shorted to ground contact 222 or when charging contact 220 is mated with charging contact 214 of base station 122. Alternatively, a diode or other means for preventing discharge of the battery could be incorporated in base station 122. The negative terminal of battery 226 is coupled to the ground contact 230 which is adapted to mate with ground contact 242 of transceiver portion 202, as well as ground contact 222 which is adapted to couple to ground contact 216 of base station 122. Additionally, a thermistor 340 could be coupled between ground contact 222 and contact terminal 342. Contact terminal 342 is adapted to be coupled to terminal 343 of base station 122. Thermistor 340 could be used to identify information about the battery, such as the temperature of the battery. Battery 204 further includes a contact 341 which is either coupled to contact 220 or provides an open circuit. When coupled to contact 352 of the base station, this enables the base station to identify the battery type. Alternatively, contact 341 could be coupled a discrete resistor within the battery to enable microprocessor 210 to identify the type of battery when contact 341 is coupled to contact 352.

Battery 204 could include additional components such as an EEPROM 345 coupled to a contact 347 adapted to mate with a corresponding contact 349 of base station 122. EEPROM 345 could store information relevant to the battery to enable the base station to correctly charge the battery or transmit data according to the present invention. Control circuit 210 could control charging source 212 differently depending upon the determination of the type of battery or information received from EEPROM 345. For example, less charging current may be required to vary the voltage of a lithium ion battery than a nickel cadmium battery or a nickel metal hydride battery. Additional contacts could be used to enable the exchange of signals with base station 122 and/or transceiver portion 202 of a mobile unit 126 as required.

Mobile unit 126 also includes a transceiver portion 202 which preferably comprises a signalling/audio ASIC 351, such as a CMOS ASIC available from Motorola, Inc. and a control circuit 248, such as a 68HC11 microprocessor also available from Motorola, Inc., or some other processing circuit, which combine to generate the necessary communication protocol for communicating with base station 122 and independently with wide area system 100 of FIG. 1. Control circuit 248 uses memory 354 comprising RAM 355, EEPROM 357, and ROM 359, preferably consolidated in one package 361, to execute the steps necessary to generate the protocol and to perform other functions for the wireless communication device, such as writing to a display 363, accepting information from a keypad 365, accepting input/output information by way of a connector 366, or controlling a frequency synthesizer 375. ASIC 351 processes audio transformed by audio circuitry 369 from a microphone 367 and to a speaker 371.

Transceiver portion 202 processes the radio frequency signals. In particular, a transmitter 373 transmits through an antenna 246 using carrier frequencies produced by a frequency synthesizer 375. Information received by antenna 246 of the mobile unit enters receiver 377 which demodulates the symbols using the carrier frequencies from frequency synthesizer 375. The mobile unit may optionally include a message receiver and storage device 380 including digital signal processing means.

Transceiver portion 202 further includes a regulator 344 coupled to power contact 240 and ground contact 242 to provide a regulated voltage to control circuit 248 and other components. Finally, power contact 240 is coupled to a voltage measuring circuit such as an analog-to-digital (A/D) converter 348 which could be a discrete component or could be integrally associated with control circuit 248. A/D converter 348 detects variations in the voltage of battery 226 and generates a digital voltage representative of the voltage detected at A/D converter 348. The digital voltage is then processed by control circuit 248 to interpret data based upon the variations of the voltage of battery 204, as will be described in more detail in the remaining figures. It should be noted that conventional circuitry commonly used in mobile units to read a battery level could be used to detect variations in battery level according to the present invention.

Finally, mobile unit 126 could optionally include a variable load 367 to enable the transfer of data in the opposite direction (i.e. from the mobile unit to the base station). In particular, transceiver portion 202 could modulate the variable load to alter the voltage of battery 226. Alternatively, mobile unit 126 could vary the load on battery 226 without altering the mobile unit by enabling or disabling other elements of the mobile unit, such as the display or light emitting diodes. Base station 122 could decode variations in the battery voltage in the same manner as applied by the mobile unit. For purposes of brevity, the remaining description of the invention will relate to the transmission of data from the base station to the mobile unit. However, it will be understood that the remaining description could apply equally to the transmission of data from the mobile unit to the base station.

After the mobile unit is inserted in the base station, the base station periodically pulses current to charge the battery, creating a momentary change in the battery voltage. Data is encoded in these periodic pulses by varying the length of time between the pulses. The mobile unit monitors the time period between each pulse to decode the contents of the data stream. In particular, data is transmitted based upon the location of the pulse within a predetermined window. A charge pulse in a first predetermined window represents a zero bit, and a charge pulse in a second predetermined window represents a one bit.

As shown for example in FIGs. 4 and 5, four windows are defined, including a first window which is not used and Windows 1-3. The four windows are represented by time frames t_1 - t_4 , respectively. The time frames could be of equal duration or different durations. In the preferred embodiment, the time frames are each 250 msecs. A zero bit is detected by control circuit 248 when a pulse is detected in Window 2, as shown in FIG. 4. In contrast, a one bit is detected by control circuit 248 when a pulse is detected in Window 3 as shown in FIG. 5. No signal is sent during the time frames of the unused Window or Window 1. This time period during the unused Window and Window 1 is used as a decay time between pulses. Depending upon the type of battery which is receiving the pulsing current, the rise and fall times may vary. The pulses shown in FIGs. 4 and 5 are shown by way of example. The voltage pulses on most batteries typically tend to rise quickly and fall slowly.

Turning now to FIG. 6, a flow chart shows the method for transmitting data according to the present invention. If the mobile unit is coupled to the base station at a step 602, the base station detects the presence of the mobile unit and transmits a header which consists of six zero bits ("000000") followed by five one bits ("11111") and then a zero bit ("0"). The header preferably precedes all messages. The mobile unit time aligns to the bit stream on the battery contacts at a step 604 by monitoring the voltage of the battery. The "00000" sequence will be referred to as 'dotting' and the "0111110" sequence will be referred to as 'sync'. The mobile unit uses the dotting bits to time align to the received signal and it uses the sync bits as validation that it has properly aligned to the signal and to indicate that a new message is about to begin. The mobile unit requires four evenly spaced pulses of dotting for time alignment. The alignment routine will attempt to place the peaks in Window 2. A conventional phase-locked loop (PLL) is used while the first four bits are received to perform the time alignment.

The mobile unit will then sync to the bit stream at a step 606. The sync pattern is unique and preferably cannot occur in the middle of a message from the base. In particular, the base is not allowed to send five one bits in a row while transmitting the message data or checksum. Any time the base sends four one bits in a row while in the middle of a message, it inserts a zero bit into the data stream. The mobile unit then removes the zero bit every time four one bits have been found in a row. Finally, the mobile unit will decode data transmitted over the battery contacts at a step 608. If more data is available at a step 610, the mobile unit will continue to decode the data at a step 608. The method for time aligning and synchronizing will be described in more detail in reference to FIGs. 7 and 8.

Turning now to FIG. 7, a flow chart shows the steps for time aligning to the bit stream. The mobile unit monitors the bit stream on the battery contacts at a step 702 by sampling the battery voltage. Preferably, the mobile unit samples the battery voltage every millisecond (msec). The mobile unit adds up these samples for 50 msec and generates averaged samples. Sampling over 50 msec provides sufficient noise immunity, which may be necessary because of high frequency noise that may be present on the battery contacts. When the first peak is detected at a step 704, the mobile unit marks the location of the bit at a step 706, and waits for the next

peak at a step 708. For a system having 250 msec windows, the next peak is expected exactly 1 second after the first peak. If it is not received at a step 710 within a predetermined period before or after the expected time, such as one hundred milliseconds of time, the system is reset, and that second pulse is considered to be the first pulse of the dotting sequence. If the next pulse is received within a 200 millisecond window centered on the predicted arrival time, the pulse is accepted and the mobile unit waits for the third pulse. If three more consecutive pulses are received after the first pulse, each within the 200 millisecond window centered on the predicted arrival time of the pulse, the system is considered to be time-aligned at a step 712.

According to the present invention, the mobile unit attempts to align a received pulse in Window 2. In order to determine whether pulses are received within a proper window, only pulses detected in Windows I and 2 are required in the time alignment portion of the task. Time alignment is done by keeping a shift register of the last 10 averaged samples and trying to align the pulse in the shift register. The last five samples in the shift register are summed to form SUM(Window 1) and the most recent five samples are summed to form SUM(Window 2). It is easy to see from looking at the diagram of the zero pulse above that when the pulse is properly centered in Window 2 that the difference [SUM(Window 2) - SUM(Window 1)] will be a maximum. The mobile unit also uses the difference to locate the peak. If the difference [SUM(Window 2) -SUM(Window 1)] is above some threshold and after shifting the windows by one sample time the new difference is smaller than the old difference, then that old difference is called the peak.

Turning now to FIG. 8, the mobile unit monitors the bit stream on the battery contacts at a step 802 to determine whether the mobile unit is properly synched to zero bits in the bit stream rather than one bits. In particular, the mobile unit waits for a pulse to appear in Window 3, thus signaling that time alignment was performed on a stream of zero bites, and that a one bit was just received. That is, if the next pulse is received in a later frame than expected at a step 804, it is determined at a step 806 that a one bit is received and the mobile unit monitors for more data at a step 902. If the mobile unit incorrectly aligned itself to one bits, a pulse will eventually appear in Window 1 (i.e. a zero pulse), indicating an error. The mobile unit

returns to the time-alignment task of looking for four evenly-spaced pulses. That is, if the next pulse is received at an earlier frame at a step 810, the mobile unit had improperly time aligned to one bits in the bit stream rather than zero bits at a step 812. The mobile unit then returns to monitor the bit stream at step 702 to properly align with zero bits in the bit stream. If the pulse is neither received at a later frame at a step 804 nor an earlier frame at step 810, a zero bit is determined to be received at a step 814, and continues to monitor the bitstream.

Since each averaged sample that this task uses is taken over a 50 ms period, each 250 msec window in the above diagram comprises 5 averaged samples. The mobile unit then uses the sums of the averaged samples in the windows to decide if a 'one' or a 'zero' was received. If pulses were received as illustrated in the above diagrams, then a one bit could be distinguished from a zero bit by simply calculating the difference between the sums of Windows 2 and 3. Such a function is preferably performed by a differential decoder in the microprocessor, and takes into account variations in battery voltage caused by normal battery decay over time or current draw on the battery during operation. A strong positive value would result if a one bit was received and a strong negative value would result if a zero bit was received. However, because of the long decay time present in the pulses, the zero pulse may extend from Window 2 into Window 3 resulting in errors when using the simple equation :

[SUM(Window 3) - SUM(Window 2)].

Accordingly, an alternate metric incorporates the use of Window 1 could be used according to the present invention. When a one pulse is received, the difference [SUM(Window 3) - SUM(Window 2)] should be fairly strong. When a zero pulse is received, the difference [SUM(Window 2) - SUM(Window 1)] should be fairly strong. The difference between these two differences could then be calculated as follows:

[SUM(Window 3) SUM(Window 2)] - [SUM(Window 2) - SUM(Window 1)].

Accordingly, a one pulse will result in a positive value while a zero pulse will result in a negative value. Also, because the sum of Window 2 enters the equation twice, the absolute value will be higher when a zero bit is received than when a one bit is received. Zero is not used as a threshold because the equation's absolute value is not the same for a 'one' and a 'zero'. Since a zero bit causes the result to become more negative than a one bit causes it to be positive, the threshold for determining a one bit or a zero bit is preferably at some point below zero which one skilled in the art could easily determine from experimentation.

Turning now to FIG 9, a flow chart shows the steps for receiving data according to step 608 of FIG. 8. After a one bit has been successfully received at step 806 of FIG. 8 indicating that the mobile unit has successfully synched to zero bits in the bitstream, the mobile unit waits for the next bit at a step 902. After receiving the next bit, the mobile unit determines whether the pattern "0111110" has been received at a step 904. If the pattern has not been received, the mobile unit will continue to wait for the next bit. If the pattern is received, the mobile unit determines that it has properly synched to the bitstream and sets the bit counter (BIT_CNT) to zero at a step 906 and waits for the next bit at a step 908.

The mobile unit then determines whether a bit pattern "11110" has been received at a step 910. If it has, the mobile unit waits for the next bit at step 908 without incrementing a bit counter. As previously described, because a valid message cannot include five consecutive one bits, a zero bit is inserted after four consecutive one bits. Therefore, the zero bit after four consecutive one bits is ignored, and the bit counter is not incremented. If the bit pattern "11110" has not been seen, the mobile unit determines whether the bit pattern "11111" has been seen at a step 912. If the pattern has been seen, the mobile unit determines that a new sync pattern is being sent and waits for the next bit at step 902. That is, the mobile unit then waits for a zero bit to be received, indicating that the mobile unit has been properly synchronized to the bitstream, or a one bit indicating that the mobile unit has not been properly synchronized to the bit stream.

However, if the pattern "11111" has not been seen, valid data is being received and the mobile unit sets the array value X[BIT_CNT] equal to the RECEIVED BIT and increments the bit count. The mobile unit then

determines whether more data is available at step 916. If more data is available, it will wait for the next bit at step 908. Otherwise, it will terminate the demodulation at a step 918.

Turning now to FIG. 10, a flow chart showing an application of the method and apparatus for transmitting data according to the present invention. In particular, if data is required to be sent from a wide area network 100 to mobile unit 126 at a step 1002, the network transmits data at a step 1004 to the base station over the landline network. The base station then transmits data to mobile unit over the battery bus at a step 1006 according to the method and apparatus described in FIGs. 2-9. The data transmitted on the battery bus begins with a dotting sequence, which is used to time align the mobile unit to the bitstream, followed by a sync sequence (SYNC_SEQUENCE). After sync has been detected, bits are placed in a buffer as they are received and a counter indicating the number of bits received is updated. A running checksum is calculated as each nibble of message data is received. The MESSAGE_LENGTH field is used to determine when the end of the message data has been reached. After the entire message is received, the CHECKSUM field is examined. If the calculated checksum is equal to the value in the CHECKSUM field, the message is processed. Otherwise, the message is discarded. Once a full message has been received, the mobile unit then decodes the data at a step 1008.

Exemplary messages according to the present invention are composed of three layers of data. Layer 1 consists of the modulated one bits and zero bits, the transmission of which is described in detail above. Layer 2 data defines base-to-mobile communication protocol and message validation requirements. An exemplary protocol according to the present invention is shown in the following Table 1:

TABLE 1

FIELD NAME	LENGTH (BITS)
SYNC SEQUENCE	7
MESSAGE TYPE	4
MESSAGE LENGTH	4

MESSAGE DATA	MESSAGE LENGTH*4
CHECKSUM	8

This structure is comprised of the SYNC_SEQUENCE, MESSAGE_TYPE, MESSAGE_LENGTH, MESSAGE_DATA, and CHECKSUM. The sync sequence, which indicates the start of a message, is preferably comprised of a specified unique data stream (0111110). The MESSAGE_TYPE is a 4-bit value which indicates the specific message being transmitted. The MESSAGE_LENGTH is a 4-bit value which indicates the number of nibbles between the MESSAGE_LENGTH field and the CHECKSUM field. The MESSAGE_DATA is optional and is defined on a message-by-message basis. Finally, the CHECKSUM field is comprised of the modulo-256 weighted sum of all of the nibbles in the message except the SYNC_SEQUENCE and the CHECKSUM fields to ensure that no data is lost.

Layer 3 data is different for each message type and is used to transmit data from the base to the portable. For example, when transferring channel information, MESSAGE_DATA comprises a PBID_LSB field containing the least significant byte of an identification associated with a base station which is transferred to ensure that the mobile unit is monitoring the correct base station. Also, an eight bit INITIAL_CHANNEL field could include the first channel number of a range of channels that the mobile unit and base station use for communication, as well as a NUM_ 10 KHZ_CHAN field indicating the number of 10 kHz channels which the base station is allowed to use. More importantly, a CURRENT_CHAN field containing the current cordless channel number which is being used by the base station could be sent.

TABLE 2

FIELD NAME	LENGTHS (BITS)
SYNC SEQUENCE	7
MESSAGE TYPE	4
MESSAGE LENGTH = 10	4
PSID LSB	8

RESERVED	3
INITIAL CHANNEL	13
NUM 10 KHZ CHAN	8
CURRENT CHANNEL	8
CHECKSUM	8

When processing the message, the MESSAGE_TYPE field is examined first. If the value of MESSAGE_TYPE is defined in the current version of the protocol, the message is processed accordingly. Otherwise, the message is discarded. Message processing is unique for each supported message type. Although the message of Table 2 having channel information is shown by way of example, any information usable by the mobile could be transmitted, including, but not limited to, number assignment module (NAM) programming information, an authentication key or repertory dialing information.

Although the invention has been described and illustrated in the above description and drawings, it is understood that this description is by way of example only and that numerous changes and modifications can be made by those skilled in the art without departing from the true spirit and scope of the invention. For example, variations in the voltage of some device other than the battery could be detected to decode data. Also, a remote device could be an electronic device such as a personal organizer coupled directly to the base station, rather than through the telephone network, to transfer repertory dialing information. Although the present invention finds particular application in portable cellular radiotelephones, the invention could be applied to any wireless communication device, including pagers, electronic organizers, or computers. Our invention should be limited only by the following claims.

We claim:

Claims

1. An apparatus for transmitting data characterized by:

a charging source;

a first contact coupled to said charging source;

a second contact providing a reference voltage;

an energy storage device coupled between said first contact and said second contact;

a voltage measuring circuit coupled to said energy storage device; and

a processing circuit coupled to said voltage measuring circuit to decode signals based upon the voltage of said energy storage device.

2. The apparatus for transmitting data of claim 1 further characterized by a modulating circuit coupled to said charging source.

3. An apparatus for transmitting data characterized by:

a first communication device comprising a charging source coupled between a first contact and a second contact; and

a second communication device comprising a charge storage device coupled between a third contact and a fourth contact detachably coupled to said first contact and said second contact, respectively, said second communication device further comprising an analog-to-digital converting circuit coupled to said third contact for decoding signals based upon said the charge of said charge storage device.

4. The apparatus for transmitting data of claim 3 further characterized by a modulating circuit coupled to said charging source.

5. A communication system having charging circuitry being adapted to transmit data, said communication system characterized by:

a base station comprising:

charging circuitry having a charging source;

a first contact coupled to said charging source; and

a second contact providing a reference voltage; and

a mobile unit detachably coupled to said base station, said mobile unit comprising:

a third contact coupled to said first contact;

a fourth contact coupled to said second contact;

a charge storage device coupled between said third contact and said fourth contact; and

an analog-to-digital converting circuit coupled to said third contact for generating digital signals based upon the charge of said charge storage device.

6. A method of transmitting data, said method characterized by the steps of:

modulating a charging source coupled to a battery;

detecting a change in the voltage of a battery; and

demodulating signals based upon the change in the battery voltage.

7. The method of transmitting data of claim 6 further characterized by a step of coupling a charging contact on a first surface of said battery to said charging source.

8. The method of transmitting data of claim 7 further characterized by a step of coupling said battery to a mobile unit.

9. A method of transmitting data between a base station and a mobile unit, said method characterized by the steps of:

coupling a charging contact of said base station to a corresponding contact of said mobile unit;

modulating a charging source coupled to said charging contact of said base station;

detecting changes in the voltage of a battery associated with said mobile unit; and

demodulating signals in said mobile unit based upon changes in the voltage of said battery.

10. A method of transmitting data from a remote device to a mobile unit by way of a base station, said method characterized by the steps of:

transmitting data from said remote device to said base station;

coupling a charging contact of said base station to a contact of said mobile unit; and

transmitting said data from said base station to said mobile unit by modulating a charging current coupled to said charging contact of said base station.

The Patent Office

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Claims searched: 1-9

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Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): H4L (LDJ, LDLX, LECC, LECTS, LECTX, LECX)

Int Cl (Ed.6): H04B 1/38, H04M 1/72, H04Q 7/32

Other: Online Database: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB2217151 A	(SONY) p.28 line 27 - p.28 line 11 & fig.7	1-9
X	EP0196834 A2	(AMERICAN TELEPHONE & TELEGRAPH) p.8 line 27 - p.10 line 7 & fig.2	1-9
X	EP0148458 A2	(MOTOROLA) p.11 line 27 - p14 line 21 & fig.3	1-9
X	EP0218482 A2	(NIPPON TELEGRAPH & TELEPHONE) p.5 line 13 - p.9 line 6	1, 3
X	US4748685	(MOTOROLA) col.14 line 63 - col.15 line 29	1-9
X	US4639550	(SONY) see fig.5	1, 3

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.